

## NERVE ROOT RETRACTOR AND SUCKER

## 5 FIELD OF THE INVENTION

The present invention is directed to a nerve root retractor and sucker; and more particularly to a nerve root retractor and sucker having an adjustable geometry.

## 10 BACKGROUND OF THE INVENTION

In the field of lumbar disc surgery there are no two more important tools than the nerve root retractor and the sucker. During an operation, the nerve root retractor is used by a medical professional to hold the nerve to one side so that the  
15 operating surgeon can remove disc material without damaging the nerve. In turn the sucker is used in turn to remove blood or other fluids that accumulate in the surgical area to ensure that the medical professional has good visualization of the surgical area during operation.

20 In such spinal surgery, the design of the sucker and nerve root retractor are very important. For example, most lumbar disc surgery suckers have a small vent hole on the top of the device such that exposing the hole leads to an instantaneous reduction in the suction force being applied to  
25 the surgical region. The ability to reduce the suction is important because during surgery the dura, or covering material in the spine is periodically breached, spinal fluid leaks out and sometimes washes nerve roots out of the dural sac. These nerve roots can get sucked into the sucker and if  
30 no mechanism for instantly reduction the suction were available the possibility would exist that the sucker could suck the nerve out through the rent in the dura and shear and/or traumatize the nerve root, possible damaging it irreparably. The vent in the sucker allows a medical  
35 professional to grossly regulate the suction being applied by

the nerve sucker thereby reducing the chances of such a catastrophic injury.

Although the nerve root retractor and the sucker have been used in surgery for many years, they require two separate hands of a highly trained medical personnel for proper operation. Having extra personnel during surgery is very costly and many insurance companies are no longer authorizing or paying for assistants for surgeons during these delicate operations. To address this new medical reality some companies have introduced dual purpose tools for both retracting and sucking. One exemplary nerve root retractor and sucker was made by Karlin Technology, Inc (Part # 46-3005). However, these devices were generally clumsy, bulky, and inflexible, and are therefore difficult to use for the delicate procedures required during lumbar disc surgery.

Accordingly, a need exists for an ergonomically and functionally improved nerve root retractor and sucker for use in lumbar disc surgery, if necessary for use by a solo spine surgeon who has no assistant.

#### SUMMARY OF THE INVENTION

The present invention is directed to an ergonomically and functionally improved combination nerve root retractor/sucker having an adjustable geometry.

In one embodiment, the nerve root retractor and sucker comprises a handle having an adjustable retractor/sucker shaft attached thereto. In one such embodiment the angle of the shaft is polyaxially adjustable with respect to the handle. In another such embodiment the handle may be designed to ergonomically fit within the hand, or may be provided with a non-slip surface, such as a knurled surface, to prevent slippage.

In another embodiment, the retractor/sucker shaft is detachable from the handle such that retractor/sucker shafts of different designs may be interchangeably attached to the handle. In one such embodiment nerve root retractor/sucker shafts having different lengths, such as from 80 to 200 mm; different widths of the retractor portion of the device (such as from 5 to 12mm; or having different fixed angles with respect to the handle may be interchanged, such as around 135 degrees. Alternatively, the nerve root retractor/sucker shaft may be designed with a low profile or offset bayonet design shaft for use with a microscope.

In yet another embodiment, the nerve root retractor/sucker shaft may be constructed of malleable materials, such as plastics or thin bodied metal tubes such that the shaft can be manually bent to conform to a desired shape, by the operating surgeon at his wish.

In still another embodiment, the handle incorporates a fixing clamp to fix the position of the retraction/suction shaft with respect to the handle when in a desired conformation.

In still yet another embodiment, the handle incorporates a suction control mechanism. In one such embodiment the suction control mechanism comprises at least one vent hole bored into the handle in communication with the suction source. In another such embodiment the handle comprises a multiplicity of vent holes such that variable suction control can be provided.

In still yet another embodiment the invention is directed to a nerve root retractor and sucker system.

In still yet another embodiment the invention is directed to a method of performing a lumbar disc operation using a nerve root retractor and sucker as described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

5       These and other features and advantages of the present invention will be better understood by reference to the following detailed description when considered in conjunction with the accompanying drawings wherein:

10       Figure 1a is a side view of a first embodiment of a nerve root retractor and sucker in accordance with the present invention.

      Figure 1b is a top view of a first embodiment of a nerve root retractor and sucker in accordance with the present invention.

15       Figure 1c is a detailed view, "view-A" identified in Figure 1a, of a first embodiment of a nerve root retractor and sucker in accordance with the present invention.

      Figure 1d is a cross-section taken along line "A-A" of Figure 1a of a first embodiment of a nerve root retractor and sucker in accordance with the present invention.

20       Figure 1e is a cross-section taken along line "B-B" of Figure 1a of a first embodiment of a nerve root retractor and sucker in accordance with the present invention.

25       Figure 1f is a cross-section taken along line "C-C" of Figure 1a of a first embodiment of a nerve root retractor and sucker in accordance with the present invention.

      Figure 1g is a side view of an embodiment of a low profile nerve root retractor and sucker in accordance with the present invention.

30       Figure 2a is a side view of a second embodiment of a nerve root retractor and sucker in accordance with the present invention.

      Figure 2b is a top view of a second embodiment of a nerve root retractor and sucker in accordance with the present invention.

Figure 2c is a detailed view, "view-A" identified in Figure 2a, of a second embodiment of a nerve root retractor and sucker in accordance with the present invention.

Figure 2d is a cross-section taken along line "A-A" of Figure 2a of a second embodiment of a nerve root retractor and sucker in accordance with the present invention.

Figure 2e is a cross-section taken along line "B-B" of Figure 2a of a second embodiment of a nerve root retractor and sucker in accordance with the present invention.

Figure 2f is a cross-section taken along line "C-C" of Figure 2a of a second embodiment of a nerve root retractor and sucker in accordance with the present invention.

Figure 3 is a cross-sectional view of one embodiment of the handle/shaft connection of the nerve root retractor and sucker in conjunction with the present invention.

#### DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to an ergonomically and functionally improved combination nerve root retractor and sucker.

Figures 1a to 1f show one embodiment of a nerve root retractor and sucker in accordance with the current invention. As shown in Figure 1a, the nerve root retractor and sucker of the current invention generally comprises a handle portion **12** having a nerve root retractor/sucker shaft **14** attached at one end thereof and having a suction connection **15** at the opposite end thereof. The nerve root retractor/sucker shaft itself comprises a hollow suction tube **16** for providing suction through a suction opening **18** at the tip **20** of the shaft and a retractor **22** for physically manipulating a nerve during operation.

In the embodiment shown in Figures 1a and 1b, the handle **12** is hollow such that it may provide a fluid connection

between the suction source (not shown) attached at the suction connection **15** and the suction tube **16**. A suction control vent **24** is bored into the handle of the apparatus to provide the user a manual means for reducing the suction provided to the tip of the apparatus during operation. Specifically, during operation if the vent is covered by the user then maximum suction is provided at the suction opening, but when the vent is left open the suction is reduced to the extent that air enters the vent into the handle. Although only a single vent **24** is shown in the embodiment picture in Figure 1b, it should be understood that any number and size of suction vents could be provided such that variable control of the intensity of the suction provided at the tip of the device may be provided.

Although in the embodiment shown in Figure 1a the shaft **14** forms a 135 degree angle to the axis of the handle **12**, it should be understood that any desired angle may be set into the apparatus. Likewise, although specific handle and shaft dimensions are shown in Figures 1a and 1b it should be understood that these dimensions may be altered depending on the desired geometry of the apparatus. Preferred dimensions for the device include shaft lengths from about 80 to about 220mm, while the width of the apparatus, and particularly the retractor, is preferably about 5 to about 12mm.

In addition, although one handle design having a knurled surface **26** is shown in Figures 1a and 1b, it should be understood that any suitable handle design may be utilized with the current invention such that a retractor/sucker shaft may be attached thereto, and suction control provided to the shaft. For example, the handle could be designed with a pistol grip or could be contoured to the hand such that the ergonomic fit of the device is better tailored to the user.

Figures 1a to 1c provide more detail into the design of the shaft **14** and the tip **20** of the shaft. As shown in Figure

1c, the tube 16 and the retractor 22 are proximately positioned one to the other such that suction may be applied and the nerve retracted simultaneously during operation. As shown in this embodiment, the retractor 22 comprises a flat blade fixedly attached to the tube 16. Although specific dimensions, angles and geometries of retractor blades are shown in this embodiment, it should be understood that any retractor blade suitable for retracting nerves during spinal surgery may be utilized in the current invention. For example, the blade may be differently dimensioned, or angled, such as in a swept back geometry, to provide a desired control geometry to the user. Alternatively, the retractor could be made adjustable, such as by having a retractable and/or variable length blade, and/or by having a pivotable variable angle blade if so desired

As shown in Figures 1d to 1f, in this embodiment because of the retractor/suction combination, the cross-section of the tube 16 changes along the length of the shaft 14 from a semi-circular geometry at the tip 20 to a full circular geometry as it approaches the handle 12. Although one particular tube design is shown herewith it should be understood that any suitable suction tube design may be utilized with the current invention. For example, in one embodiment the tube may have a circular, square, or triangular geometry that is either fixed or variable along its length.

Moreover, although a single retractor/sucker shaft being permanently affixed to the handle is shown in the embodiment pictured in Figures 1a and 1b, it should be understood that a detachable shaft may be used in the current invention. One exemplary embodiment of a suitable detachable shaft connection is shown in Figure 3, however, any suitable fixed geometry or variable geometry attachment may be used in the current invention. For example, the shaft may be attached through a

threaded connection, a snap-fit connection, or a friction connection. In such an embodiment, the apparatus may include multiple shafts having variable lengths and/or geometries such that the user can change the instrument to suit any instantaneous need during an operation.

In addition, although a conventional shaft design is discussed above, the shaft may be provided in a bayonet or other low profile design for use where visualization of the surgical area is required, such as when a microscope technique is used. One exemplary embodiment of such a bayonet or "offset" nerve root retractor and sucker is shown in Figure 1g. As shown, in this embodiment the shaft **14** is bent at a nearly 90 degree angle from the handle **12**. In addition, the tip portion **20** of the shaft **14** has a further bend section **28** to provide the user better visualization of the retractor **22** and, in turn, the retracted nerve when using a microscope. Although any suitable offset distance **29** may be utilized, in one embodiment the offset is about 1.5 to 1.75 inches.

Although only fixed geometry nerve root retractor and suckers are discussed above, one variable geometry embodiment of the nerve root retractor and sucker according to the present invention is shown in Figures 2a to 2f. As shown, in this variable geometry embodiment, like in the fixed geometry apparatus discussed above, the nerve root retractor and sucker **30** generally comprises a handle portion **32** having a nerve root retractor/sucker shaft **34** attached at one end thereof and having a suction connection **35** at the opposite end thereof. Moreover, the design of the nerve root retractor/sucker shaft including the hollow suction tube **36**, the suction opening **38**, and the retractor **42** are also identical to those discussed above in relation to Figures 1a and 1b. In addition, the handle **32** of the embodiment shown in Figures 2a and 2b, like those shown in Figures 1a and 1b, is hollow such that it may



provide a fluid connection between the suction source (not shown) attached at the suction connection 35 and the suction tube 36. A suction control vent 44 is also bored into the handle of the apparatus to provide the user a manual means for reducing the suction provided to the tip of the apparatus during operation, and any number and size of suction vents could be provided such that variable control of the intensity of the suction provided at the tip of the device may be provided.

However, in contrast to the fixed geometry device, in the embodiment shown in Figures 2a and 2b, the connection 46 between the handle 32 and the shaft 34 is designed to allow the movement of the shaft relative to the handle in at least one axis. As shown in Figures 2a and 2b, preferably the connection is designed to provide polyaxial movement to the shaft.

One embodiment of a connector 50 suitable for providing polyaxial movement to a nerve root retractor/sucker shaft in accordance with the current invention is shown in Figure 3. As shown, the connector 50 generally comprises a cap 52 against which a connection end of the nerve root retractor/sucker shaft 54 is retained and through which a suction end of the nerve root retractor/sucker shaft 56 extends, and which is designed to threadingly mate with a connector end of the handle 57 and thereby secure the shaft therein.

Specifically, the connector 50 comprises a cap body 52 having an inner threading 58, which is intended to mate with the threading 60 on the connection end 57 of handle. A central annular opening 62 is provided in the center of the connector 50 defining a passage 64 passing therethrough, the passage 64 and opening 62 being designed such that the suction end of the shaft 56 can fit therethrough, but through which the

connection end of the shaft 54 cannot fit, such that when the connector 50 is connected to the connection end of the handle 57 the shaft is retained, as shown in FIG. 3.

In such an embodiment, as shown, the connection end of the shaft 54 may be designed in a ball and socket arrangement, with an expanded spherical portion 66 which allows polyaxial motion of the shaft, and which is also dimensioned to prevent the connection end of the shaft from slipping out of the opening 62. In turn, to prevent the shaft from slipping down into the internal passage 68 of the handle, the connection end of the shaft should be dimensioned such that the diameter of the spherical portion 66 is greater than the diameter of the internal passage 68 of the handle. In such an embodiment, tightening the connector cap 52 onto the connection end of the handle 57 presses the spherical portion 66 of the shaft 54 against the opening of the handle 57 which serves to both attach the shaft 54 onto the handle and simultaneously prevent further polyaxial motion of the shaft, thereby fixing the angular position of shaft in relation to the handle. In addition, it should be understood that where suction is directed through the handle to the distal end of the shaft that the connection between the shaft and handle must be designed to be substantially air tight to prevent leakage and a reduction in the strength of suction at the connection joint. For example, either of the spherical portion of the shaft or the connector may be made of a semi-resilient material such that an air tight seal is formed therebetween when tightened.

Although one embodiment of the connector is shown in Figure 3, it should be understood that alternative designs that allow some continuous or graduate axial movement of the shaft in relation to the handle may be utilized. For example, the cap may take any suitable form, such as an externally

threaded cap to provide a low profile device, or a cap having an entirely different connection scheme such as a snap on cap or a frictionally connected cap. Moreover, as shown, the opening 62 may have angled edges 70 to provide greater angular movement to the shaft. It should be understood that while an angular opening of about 60 degrees is shown in this embodiment, any angle suitable for retaining the shaft therein may be used. In addition, although a spherical shaft connection is shown in this embodiment, any suitable connection end that allows the retention of the shaft within the cap while simultaneously providing some motion to the shaft can be utilized. For example, the shaft connection may be hinged, or may include a partial or semicircular shaft end to provide movement of the shaft in at least one axis.

In addition, although Figures 2a and 2b show a device with a range of movement along the vertical and horizontal axis of about 60 degrees, it should be understood that any suitable range of movement could be provided. For example, notches could be etched into the side of the connection shown to provide greater than 90 degrees of movement to the shaft.

Regardless of the particular mechanical design used for the apparatus of the current invention it should be understood that any biologically suitable material may be used in the current invention, such as metals, alloys, plastics, ceramics, etc. In one embodiment both the handle and shaft are constructed of one material. Alternatively, the handle and shaft may be made of different materials. In one such embodiment, the shaft is made at least partially of a malleable material, such as a precious metal alloy, or a plastic that would allow a user to deform the shaft into a desired shape during operation.

The invention is also directed to a nerve root retractor and sucker system including a single handle as described

above, in combination with a plurality of detachable nerve  
root retractor/sucker shafts. In this embodiment a variety of  
5       different shaped, sized, or constructed shafts could be  
provided such that the user could change the geometry of the  
nerve root retractor and sucker to conform with the changing  
conditions of the surgical opening.

Finally, the invention is also directed to a method of  
10       using a nerve root retractor and sucker as described above in  
a spinal surgery procedure. In this embodiment the nerve root  
retractor and sucker would be utilized after opening the  
patient to clear the surgical opening of fluids and debris  
using the sucker, while preventing damage to the nerve by  
15       retracting it from the area of interest.

Although specific embodiments are disclosed herein, it is  
expected that persons skilled in the art can and will design  
alternative nerve root retractor and sucker devices, systems,  
and methods of using such devices and systems that are within  
20       the scope of the following claims either literally or under  
the Doctrine of Equivalents.